DDF annual report

Title of Investigation:

Rapid Prototyping of Sonification Schemes to Inform the Development of Tool to Make NASA Images Accessible to Blind Students

Principal Investigator:

Dr. Nancy Maynard (Code 610)

Other In-house Members of Team:

Drs. Susan Hoban and Daniel Laughlin (University of Maryland-Baltimore County)

Other External Collaborators:

Dr. Robert Shelton (Johnson Space Center)

Initiation Year:

FY 2005

Aggregate Amount of Funding Authorized in FY 2004 and Earlier Years:

$0

Funding Authorized for FY 2005:

$20,000

Actual or Expected Expenditure of FY 2005 Funding:

GEST Cooperative Agreement: $20,000 to student programmers (Drake Deming, Greg Parkins), mentored by Hoban and Laughlin (who were not permitted to charge time)

Status of Investigation at End of FY 2005:

A small amount of residual funding from the FY 2005 DDF allows Drake Deming to stay onboard during the semester to fine-tune the code, prepare the documentation, and contribute to the development of a paper that we plan to submit to the International Community for Auditory Display (ICAD 2006). The broader project, called *"EARTH+: Dynamic NASA Earth Science Exploration For Blind Learners"* (for which this DDF served as a prototype) has been funded for 3 years (FY 2006-2008) through the Science Mission Directorate as part of education efforts in Earth science.

Expected Completion Date:

May 2006; EARTH+, October 2008

Purpose of Investigation:

"...In such a study, the eyes of the spirit and the habit of concentration will replace the lost vision"—
Henri Léon Lebesgue advising blind mathematician Louis Antoine to study
3-dimensional topology

NASA produces image products that are used by scientists, teachers, and students. With the exception of a few space science and solar images, which have been rendered into tactile objects, most of these products are not accessible to blind users. The goal of this project was to test various existing ways to convert numbers to sound (or sonification) to determine if a scheme existed that would allow blind students to explore a NASA image without the need for feature identification by a sighted person.

Accomplishments to Date:

A working prototype has been developed in Java that enables the user to receive auditory feedback (usually a change in pitch). This auditory signal represents the underlying data value as the cursor moves across an image. The user is able to click the mouse to query a location on the image and leave "markers" at important points. The user also may easily skip back to a marker to get reoriented. A list of markers can be pre-loaded as navigational aides or to mark points of interest. A JavaDocs library was created for the prototype's code. The summer students provided a brief (and incomplete) survey of the literature regarding sonification applications for blind users. In August, the prototype was demonstrated to Dr. Shelton and his team from Johnson Space Center.

Lessons Learned:

The point of a prototype is to develop lessons learned for future work. This DDF was intended to provide insight for a much-larger proposal to study potential ideas and pitfalls for the sonification of NASA data.

We approached this problem with the naïve idea that a teacher would be able to easily locate a relevant NASA Earth science image and import it into our application. We were attempting to use MODIS data, not the JPEG image products that are highly processed. This approach failed because of the complete absence of content-based search tools, which would allow a user to locate data containing features of interest (e.g., a hurricane or volcano). After declaring this approach a failure, we settled for using preprocessed JPEG images.

The students encountered a problem translating color information (red, green, and blue) values greater than 8-bits to sound. Deming is still searching for a solution to this problem.

It was discovered that the primary software used by the blind for reading text on the screen, *JAWS*, could not read the function buttons created by the students. As a result, the students opted for a quick fix by using voice software to read individual buttons. This clearly is not the solution. Whatever is developed in the final product must be compatible with *JAWS*.

It was late in the summer when the students first interacted with Dr. Shelton. He informed them that blind people don't use the mouse; they use keys to navigate the screen. Consequently, the prototype will have to be recoded to use keys.

More in-depth research into previous sonification efforts subsequently uncovered the fact that other auditory representations, such as tempo (like a Geiger counter), might represent a more viable approach. Deming will add this option to the current prototype during the Spring 2006 semester.

Papers for Presentation:

We have submitted a paper for presentation at the International Community of Auditory Display (ICAD 2006).

Planned Future Work:

As part of the EARTH+ project, led by Dr. Robert Shelton, an application will be developed for use as an educational tool for blind learners. The University of Maryland-Baltimore County team will be evaluating the educational effectiveness of the tool and providing training for educators.

Key Points Summary:

Project's innovative features: Although previous efforts have demonstrated the feasibility of sonification to augment NASA data for sighted users, this project was specifically tackling the problem of navigation in a two-dimensional image by blind users. The spatial analysis process for a blind user is a fundamentally different process than for sighted users.

Potential payoff to Goddard/NASA: The payoff to Goddard has already been realized. We have been funded to pursue this idea on a much larger scale. The payoff to NASA will require longitudinal evaluation: Are we able to help educate and prepare the next generation of NASA scientists and engineers

The criterion for success: The criterion for success was a working prototype.

Technical risk factors: The primary risk factor is very straightforward to describe, if not to mitigate: We do not understand spatial analysis by individuals who are blind, and yet this is at the crux of their ability to interpret image data. While we were able to put together a working prototype, there was insufficient time or funding in this DDF to test the application in any meaningful way.